

Mk-2 dye for Dye-Sensitized Solid-State Solar Cells with Copper Iodide as a Hole Transport Material.

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Abstract

Dye-sensitized Solid-state Solar Cell (DSSC) has been received great deal of attention due to its attractive features over the wet type Dye-sensitized Solar Cells (DSCs). However the configuration of DSSC, n-type semiconductor/ dye/ p-type semiconductor susceptible to have charge recombination and that would lead to have low photovoltaic performance than liquid DSCs. The metal-free organic dye, which comprises of Donor- π spacer-Acceptor (D- π -A) configuration is identical dye structure for diminish the recombination and consists several advantages as a sensitizer. Alkyl-functionalized carbazole dye MK-2 comprises (D- π -A) architecture, where carbazole and cyanoacrylic acid act as a donor and acceptor group respectively. The long alkyl chain is susceptible to decline the charge recombination by providing long distance for charge separation and suppress the dye aggregation due to steric hindrance. DSSC was prepared by deposition of $\sim 15\mu\text{m}$ thickness of nanoporous layer of hydrolysis TiO_2 with P25 Dugessa powder on FTO substrate and dyed with MK-2 dissolved in acetonitrile / tert-butyl alcohol (1:1 by volume) and also in toluene. Inorganic hole conductor CuI was used as a p-type semiconductor with adding Triethylaminethiocyanate (TAT) as crystal inhibitor. UV-visible absorption data has shown MK-2 is capable of absorb boarder wavelength 400-700 nm in visible range. MK-2 dissolved in acetonitrile / tert-butyl alcohol has shown higher photovoltaic performance, 0.496 V open circuit voltage, 16.14 mAcm^{-2} current density, 0.42 fill factor with overall efficiency 3.33% under 1.5 AM illumination than MK-2 in toluene. Photon-to-current Conversion Efficiency(IPCE) results has indicated more than 55% of photon converted into current in the range of 400-650 nm for DSSC based on MK-2 dye. SEM images of CuI films reveal the crystal inhibition ability of TAT. Alkyl-functionalized organic dye can be successfully use to sensitize DSSCs.

Keywords: Dye-sensitized Solid-state Sola Cell, Alkyl-functionalized carbazole dye, Copper iodide